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Suitable Wasteland Management strategies for Productive land zoning in Purulia District of West Bengal

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Abstract

Geographically, Purulia is an agriculturally drought-prone and backward district of India. The mapping of degraded and wasteland distribution and district base figures are very important for land resource assessment and management. This study explores ways to reduce the effects of agricultural drought in the district by implementing management strategies for seven types of wastelands. The main objective of the present study is to study the spatial distribution of different types of wastelands, to suggest suitable measures for reclamation of different types of wastelands and to recommend some possible indigenous management measures. The present study is based on both primary and secondary sources of data. Primary data were collected by intensive field survey and secondary data were collected from various Government departments like Census of India, Geological Survey of India, District statistical handbook and District statistical office of Purulia, Department of Agriculture, Govt. of West Bengal, Block Development Offices. Wasteland classes are separated by rigorous field surveys and represent higher-resolution satellite data and new topographical sheets. Based on the analysis of secondary and primary data and information, the authors in the present context have given appropriate suggestions towards the sustainable development of the wastelands of Purulia district. As a result of this study, it is promising to decrease the amount of wasteland in the district in the future.

Keywords: wastelands, agriculturally, management, reclamation, sustainable development.

1. Introduction:

The term 'wasteland' is essentially understood as degraded land which can be brought under vegetative cover with reasonable effort and which is currently under-utilized and or land which is deteriorating for lack of appropriate water and soil management or an account of natural causes (Wastelands Atlas, 2010). According to the Thorat Committee (1982), "Land that's been unused or unproductive for five years or more is classified as wasteland." This includes land that has been abandoned, neglected, or left idle for an extended period, such as unused agricultural land, degraded forests, or vacant urban lots. Identifying such land is crucial for exploring opportunities to restore, develop, or repurpose it for uses that are more productive. Wasteland is described differently by

various groups, but typically encompasses land that is degraded, idle, or uncultivated, highlighting opportunities for restoration and development. The National Wastelands Development Board (NWDB) defines "wasteland as land that has been degraded and is currently not being used due to various limitations or obstacles". India, with only a small fraction of the world's land area (2.4%) and grazing land (0.5%), supports a disproportionately large share of the global population (16%) and cattle population (18%), leading to immense pressure on its land resources, often exceeding its sustainable capacity (Wastelands Atlas 2010). As a result, large areas of productive land are continually deteriorating and rapidly converting into wasteland. India has a vast amount of wasteland, covering around 47 million hectares, which is roughly 14% of the country's total land area, according to the 2010 Wastelands Atlas.

The concept of "Wasteland" has its roots in 13th-century English common law, where it referred to land left vacant or unused but capable of being transformed into productive land through good governance and management. Wastelands are generally considered to be areas that are not living up to their potential, with productivity levels below 20% of what they could be, although a precise definition remains elusive (Mishra et al. 2013). Various sectors have their own definitions of wasteland based on land use patterns: ***i) Agricultural sector:*** land left fallow for over 2 years is considered agricultural wasteland, ***ii) Revenue Department:*** barren land unfit for agriculture is termed revenue wasteland, ***iii) Forest Department:*** grasslands or land without tree cover is classified as forest wasteland (Luna, 2006).

The drought-prone Purulia District in West Bengal mirrors the previously described situation, with no distinctive differences. Widespread deforestation and inadequate irrigation systems are the primary factors contributing to the creation of extensive wastelands in the region under study. Understanding the causes of wasteland generation in detail is necessary in order to address land degradation. Gaining this insight is an essential first step towards creating practical solutions to stop, manage, and even reverse decline. A comprehensive and integrated approach is necessary for the revitalization of wastelands, involving the development and implementation of strategies and policies that harness traditional methods to enhance food security, energy resources, and livestock feed by restoring these areas through sustainable land management and afforestation practices. The National Wasteland Development Board, which has been instrumental in the government's efforts to develop wastelands, has provided substantial assistance for these efforts.

1.1 Study Area:

Purulia District, which is in the western portion of West Bengal, is situated on the eastern end of the Chotonagpur plateau. It is formed like a funnel and is bordered by latitudes 22°40' N to 23°42' N and longitudes 85°49' E to 86°54' E (Figure 1). The district of Purulia is bordered to the east, west, and north by the state of Jharkhand, and to the east by the districts of Barddhaman, Bankura, and Jhargram in West Bengal. The district covers 6,259 square kilometers in total area.

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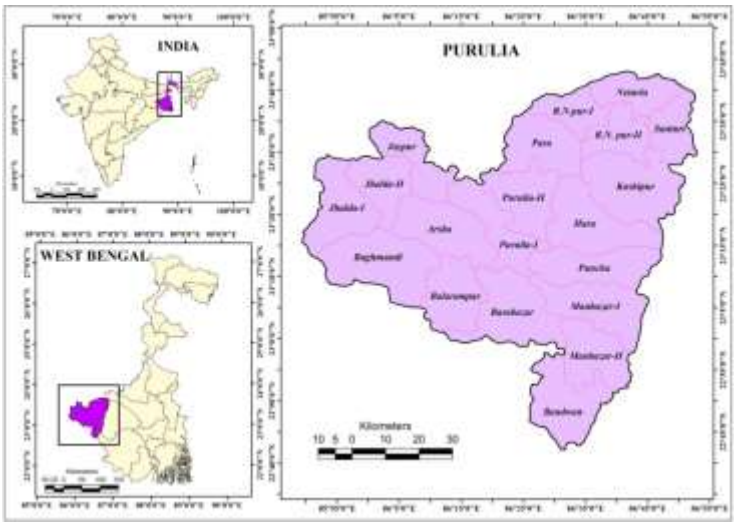

Fig. 1: Location Map of the Study area

2. Materials and Methods

2.1 General landscape of wasteland: Purulia is located in the eastern part of India, and its landform and structure are indeed part of the Ranchi Peneplain. The Ranchi Peneplain is characterized by its relatively flat terrain, which was formed through long-term erosion, flattening the surface over millions of years (Dunn & Dey, 1942). The region also has several low hills and rivers flowing across it. The nature of terrain and its features indicate that except the hilly areas, the general height ranges between 200-300 metres above mean sea-level. Two main hills of the district are Ajodhya (720 m) and Panchet (643 m); Aside from these, monadknocks with slopes and rocky-out crops are common, while the remaining undulating and rolling land is mostly lateritic. Geomorphological and pedological processes interact on the physical landscape to form distinct landforms that have a significant impact on soil types and distribution. Thus, the landscape pattern corresponded to a specific soil type (Mukhopadhyay, 1980). The landscape is plain, with residual hills, hillocks, dome-shaped mounds, dissected valleys, and so on. The presence of heterogeneous rounded pebbles mixed with laterites indicates that they were transported by rivers from Chotonagpur's uplands (Mukhopadhyay, 1980). Purulia district is prone to environmental hazards, including drought, soil erosion, inundation, waterlogging, and bank erosion, particularly during the southwest monsoon (Banerjee, 1983). The Kangsabati basin in central Purulia has a distinct landscape that differs from its surroundings, with varied topography and notable geomorphic features in its wastelands. The landforms of the district have been shaped by a blend of internal geological activities and external environmental influences. The texture of the landscape varies due to erosion stages and differences in rock composition. Earth movements are believed to have caused interruptions in the processes of the cycle of erosion, introducing complexity in the landform types in the district (Mukhopadhyay, 1980 & Banerjee, 1980). The Ajodhya Hills and surrounding areas are evidence of past semi-arid climatic conditions that were later modified by fluvial (river) processes in the current humid climate (Mukhopadhyay, 1980).

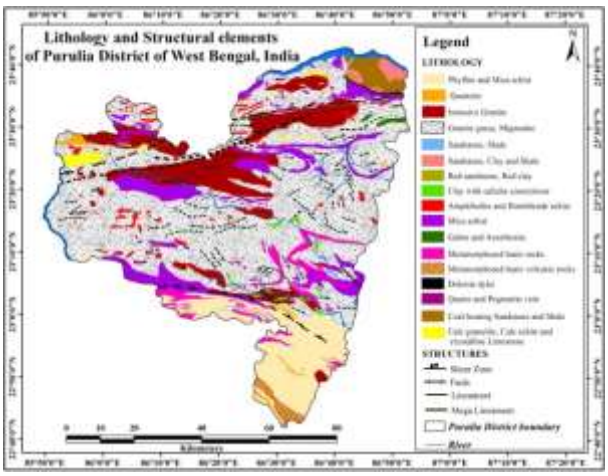

Fig. 2: Geological Structure of Purulia District

Source: *Geological Map, published by Geological Survey of India, 2001*

The landforms initially formed in a semi-arid environment have undergone significant transformations due to river activity, driven by a shift to a humid climate (Banerjee, 1983). The endogenetic processes, such as tectonic activity, volcanism, and plate movement, are likely responsible for shaping the major landforms of the Chotonagpur Plateau region (Dunn, 1929). The Chotonagpur Plateau's unique landscape is a testament to the complex interplay of endogenetic and exogenetic processes that have shaped the region over millions of years. Renowned geologists (Dunn, 1942; Singh, 1969 & Mukhopadhyay, 1980) stated that the uplifts of the Tertiary period have left a deep impression on the geology of the area. Weathering, mass wasting, or the movement of debris on slopes, and fluvial dynamics can all be better understood when the surface material is in its current state.

2.2 Spatial Distribution of Existing Wasteland: The spatial distribution of existing wastelands in Purulia district refers to the geographic location and arrangement of wasteland areas within the district. Purulia district is marked by a diverse range of seven different types of wasteland, scattered throughout the district's landscape. As of [March 2022], the Purulia district's total wasteland area is roughly 21.50% (134,447 hectares/1334.47 sq. km.) of the district's total area (out of 6,259 sq. km.), according to the *Land Records Department of the Government of West Bengal*. The district has seven distinct types of wasteland extent across 6259 square kilometers. These are as follows:

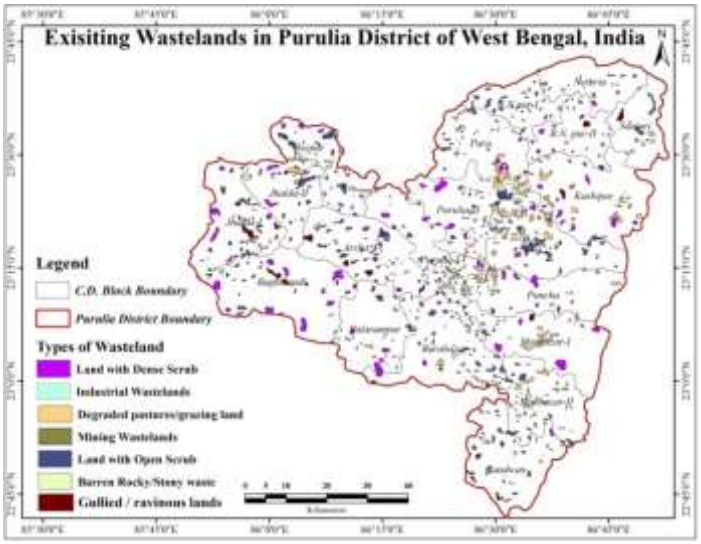

Fig. 3: Wastelands of the District

Data Source: Wasteland Atlas of India, 2019

2.2.1 Land with dense forest: The Southwestern Blocks of Purulia district, including Bagmundi, Arsha, Balrampur, and Jhalida I&II, have the highest concentration of these types of wastelands. Dense forest land is characterized by dense tree cover, with a canopy density of 40% or more (ISFR, 2023). These areas are characterized by a dense growth of trees, shrubs, and undergrowth, with minimal open spaces. Dense forests support diverse plant and animal life, including rare species, and help prevent erosion and landslides through tree root soil stabilization (Mondal, et al., 2023). Dense forests provide various ecosystem services, including timber, fuelwood, and non-timber forest products, as well as recreational and tourism opportunities.

Plate-1*: Land with dense forest* **at Sarberia Mouza** of Barabazar C.D. Block; this plate shows the different species of primitive trees such as sal, kendu, and palash have created a deep forest wasteland.

2.2.2 Land with open scrub: Land with open scrub is typically marked by a sparse and scattered growth of shrubs and bushes, with little to no tree cover (Marchang, R. 2021). Land with open scrub can be found in various parts of Purulia District, often in areas with poor soil quality, limited rainfall, or degraded land. A large area of wasteland extends across Purulia District, covering eight blocks from southwest to northeast, including Bandwan, Manbazar-II, Barabazar, Arsha, Jhalida-I and II, Joypur, Hura, and Para.

Plate-2: In ***Madhupur Mouza of Bandwan C. D***. Block, this open field wasteland is seen, here various types of shrubs like Palash, Neem, Karanj and Thorns are seen.

2.2.3 ***Barren rocky / Stony waste:*** Barren rocky/stony wasteland is a degraded area with exposed rocks, poor soil, and no vegetation, prone to erosion and unsuitable for cultivation (Singh, et al., 2022). Several blocks, namely Barbazar, Joypur, Puncha, Hura, Kashipur, Raghunathpur-I, and Jhalida-II, are characterized by significant wasteland areas. Barren rocky/stony waste can be a valuable resource, supplying stone for construction, infrastructure, landscaping, and other industrial applications (Mishra, P.S. & Bauri, B. 2024).

All the plates depict the current state of barren rocky/stony waste in various locations across Purulia district. They highlight the urgent need for environmental restoration and sustainable practices in the area.

The two pictures above show granite quarries in ***Panjania Mouza*** of ***Hura C.D. Block***; one picture shows rocky land in ***Purulia C.D. Block***, and the other shows gravel being made from basalt in **Taladih Mouza** of ***Barabazar C.D. Block***. The land's contribution to the sculpture industry and granite quarries is substantial, with basalt playing a crucial role in gravel production, construction, and infrastructure development. This highlights the land's importance in supporting local economic activities and providing essential materials for building and development projects.

2.2.4 Mining Wastelands: Mining wastelands are areas ravaged by mining operations, resulting in devastated landscapes, soil degradation, erosion, and serious environmental contamination (Kumar, R. S. 2015 & Liu, et al., 2022). Purulia district, located in West Bengal, India, is part of the Chotanagpur plateau, which is known for its rich mineral deposits (Dunn, J.A. Dey & A.K. 1942). The district is endowed with a variety of minerals, including Coal (*Nituria*), Limestone (*Jhalda and Bagmundi*), Granite (*Almost all blocks of the district*), Mica (*Ajodhya and Baghmundi*), Basalt (*Barabazar and Balarampur*), Quartz (*Jhalda and Purulia*), Feldspar, Apatite and Rock Phosphate, Dolomite (*Jhalda and Baghmundi*), Iron ore, copper, manganese, and chromite, making it a significant contributor to India's mineral production (Rai, S. N. 1996).

The three **photos** above show basalt extraction in Barabazar block, while one shows the waste deposit of the **Sponge Iron Factory** in **Neturia Block**, which is transforming previously used land into wasteland.

Locals of **Barabazar block**, especially ***Sarbariya Mouja***, use **Rock Pits** as temporary reservoirs, which serve dual purposes for bathing and irrigation. Preserving and repurposing these water bodies could potentially reduce the extent of wasteland in the area, benefiting the local community.

Aquaculture appears to have the potential to meet the protein needs of local communities and at the same time provide a sustainable resource to the area through various initiatives. In contrast, the industrial waste from **Neturia Block's** sponge iron industry, although costly and requiring careful planning, can be repurposed in various valuable ways, such as power generation, heavy metal removal, construction materials for housing and road construction.

2.2.5 Industrial Wastelands: Industrial wastelands refer to areas of land that have been degraded or polluted due to industrial activities (Resen, et al., 2022), such as mining, manufacturing, or energy production (Kong, et al., 2022 & Abdayem, et. al.,2024). These areas can pose significant environmental and health risks and often require costly remediation efforts (Mahato, B., 2021). In Purulia district, industrial wastelands are predominantly found in several areas, including: Raghunathpur-I, Neturia, Para, Santuri, Purulia-II, and Balarampur. These areas have been significantly impacted by industrial activities, resulting in wasteland formation.

The **two plates** illustrate industrial activities in the region: ***Plate 1***: Sponge Iron Industry in Nituria Block and ***Plate 2***: Thermal Power Plant in Raghunathpur Block.

In contrast, the industrial waste from **Neturia Block's** sponge iron industry, although costly and requiring careful planning, can be repurposed in various valuable ways, such as power generation, heavy metal removal, construction materials for housing and road construction.

2.2.6 *Degraded Pastures / Grazing land:* Degraded pastures/grazing lands are areas of land that have been compromised by overgrazing, erosion, or neglect, resulting in decreased productivity and ecological value (Barbieri, R.F. & Féres, J.G. 2021; Minea, et al., 2022). Deteriorated pastures and grazing lands are a prevalent issue across several blocks in the region, specifically Hura, Puncha, Para, Kashipur, Purulia I & II, Manbazar I & II, Barabazar and Balarampur.

The first picture shows **Sarberia Mouza** in **Barabazar C.D. Block**, which was once a cultivated land but has remained fallow for 10-12 years, ultimately transforming into a wasteland.

In the second film, **Bamni Mauza** of **Manbazar C.D. Block** is shown, where agricultural land has been converted to pastures for the last 2-3 years due to lack of rainwater and is in danger of turning into fallow land if timely intervention and planning are not implemented.

The economic significance of grazing lands and pastures is substantial, encompassing numerous benefits including animal husbandry, meat and dairy industries, employment opportunities, rural development, soil conservation, food security, economic diversification, promotion of mixed farming, recreational activities, and organic farming. These advantages emphasize the significance of grazing lands and pastures being managed sustainably and conserved (Minea, et al., 2022).

2.2.7 Gullied / Ravenous lands: Gullied/ravenous lands are those that have been severely degraded by runoff, poor soil structure and management, topsoil loss, fertility loss, flash floods, and deforestation (Manna, M. Mondal, B.K. 2019 & Dagar, J.C. 2018). These wastelands are primarily found in the district's hilly and sloping regions, particularly near Ayodhya Hills, Bandwan Hills, and Jaichandi Hills. The rugged terrain and harsh climate in these regions accelerate soil erosion and landslides (Bhattacharya.et al., 1985 & 2001), resulting in the degradation of land and creation of wastelands (Ghosh, S. 2012). Revitalizing wastelands requires a multifaceted government approach that harnesses tourism infrastructure, cultural heritage, rural development, adventure activities, and innovation to stimulate economic growth.

The attached images display Purulia's Gully area, with the first image captured at **Sharangdi Mauza, Ayodhya Hills, Baghmundi C.D. Block**, and the second image representing **Mangal Mouza, Bundwan C.D. Block**.

2.3 Zonal distribution of Wastelands in Purulia District: According to the C. D. Block wise distribution, the C.D. Block with the greatest percentage of its area that is classified is Arsha Block with 19 per cent, followed by the hilly and highly gradient rugged Blocks Baghmundi, Barabazar, Jhalda-I& II, Hura, Joypur and Bandwan. These predominance of the hilly and highly gradient rugged Blocks are exists maximum portion of wasteland, because of the extent of very much diversified with dome-shaped inselbergs, spurs, escarpments, undulating upland (Table: - 1).

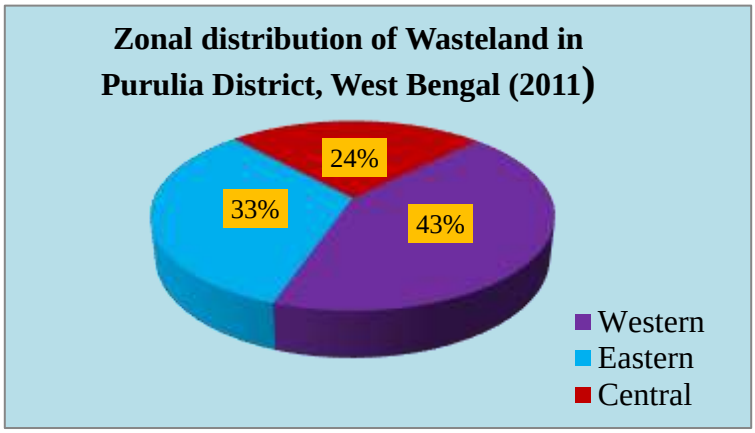

Fig. 4: Zonal distribution of Wasteland in Purulia District (2011)

Table- 1: C.D. Block-wise different types of Wasteland of Purulia, West Bengal in 2011

ZONE						*Area in Acres*
	C.D. Blocks	Barren and Uncultivable land	Area under Non-agricultural Uses	Culturable Waste Land	Total Waste land	Zonal total Waste land
Western	**Jhalda-I**	317.44	4673.05	155.81	5146.3	**49959.97**
	Jhalda-II	230.42	6079.91	297.16	6607.49	
	Arsha	304.01	8721.95	337.44	9363.4	
	Joypur	294.39	7315.82	221.92	7832.13	
	Baghmundi	224.06	4651.68	571.52	5447.26	
	Balarampur	150.42	5708.88	522.88	6382.18	
	Barabazar	271.68	8140.41	769.12	9181.21	
Eastern	**Manbazar-I**	198.72	4439.91	604.2	5242.83	**38253.74**
	Manbazar-II	153.63	6026.04	410.4	6590.07	
	Bandwan	137.61	3932.78	116.28	4186.67	
	Puncha	134.39	2674.71	497.8	3306.9	
	Hura	182.41	9113.06	565.44	9860.91	
	Santuri	70.36	3328.98	161.12	3560.46	
	Kashipur	99.22	5074.56	332.12	5505.9	
Central	**Purulia-I**	86.72	5063.98	449.16	5599.86	**28408.67**
	Purulia-II	89.91	4853.14	348.08	5291.13	
	Para	94.72	4123.08	290.32	4508.12	
	Raghunathpur-I	61.44	3911.64	296.4	4269.48	
	Raghunathpur-II	32.05	4281.66	319.21	4632.92	
	Nituria	67.24	3700.2	339.72	4107.16	

Source: *Census of India 2011, PART XII-A*

The above table shows zone-wise different types of wastelands. The Western zone shares the maximum number of wastelands, followed by the Eastern and Central zones. The

Southern zone, while having a smaller proportion, still contributes significantly to the overall wasteland area. This distribution highlights the need for targeted environmental management strategies in each zone to address the unique challenges they face.

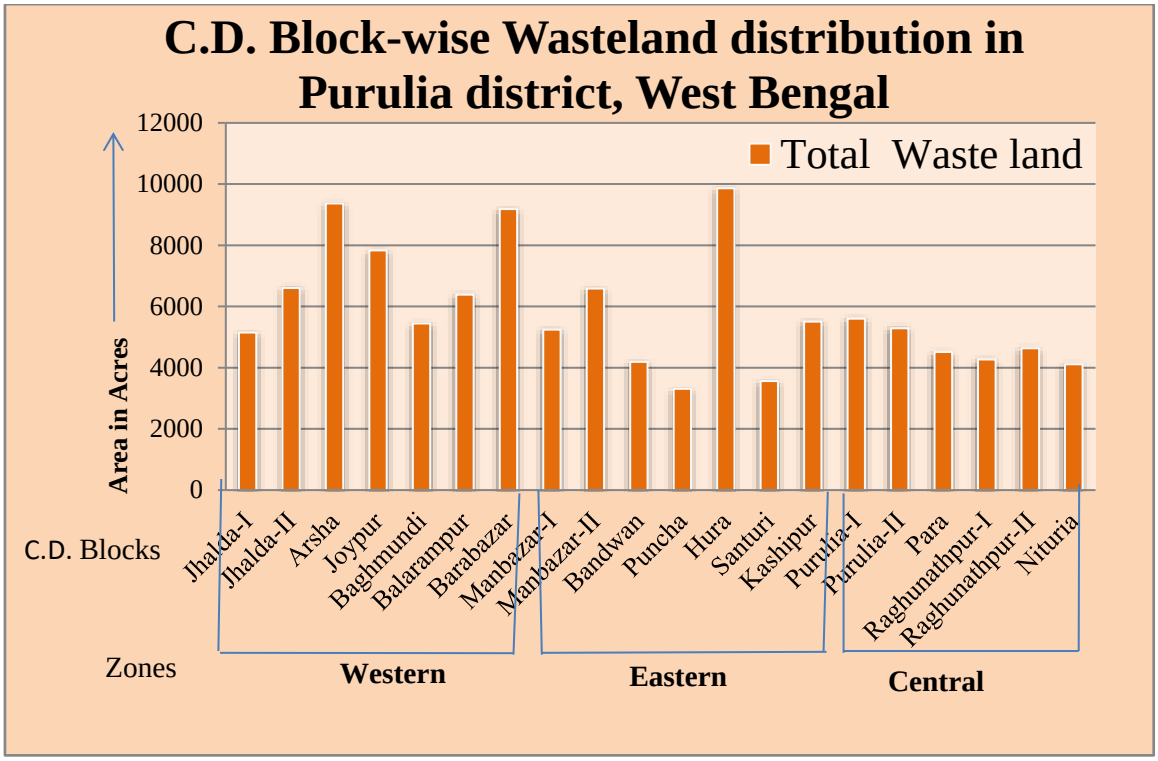

Fig. 5: C.D. Block-wise Wasteland distribution in Purulia district
Source: *Census of India 2011, PART XII-A*

2.4: Wastelands Management Schemes and Programmes in Purulia district:
The existing management schemes integrate three divisions for developing the wastelands through different plans and projects. These are:

2.4.1 Role of Central Government: Effective April 1, 1995, the Integrated Wasteland Development Programme (IWDP) and Drought Prone Areas Programme (DPAP) were merged under the umbrella of the Watershed Development Programme. The primary objectives of Watershed Development Projects were:

a) Conservation, restoration, and sustainable use of natural resources within the watershed area.

b) Sustainable development to maintain ecosystem balance and stability.

c) Improving the quality of life and life expectancy of local communities through collaborative efforts with community groups and NGOs.

2.4.2 Role of State Government: The ***Department of Irrigation and Agriculture*** has initiated projects, including the construction of check dams and micro-irrigation systems, to promote agricultural development. All check dams and irrigation projects provide a comprehensive solution, offering irrigation water, groundwater recharge, domestic water supply, and soil erosion prevention. However, the water.

storage is short-lived due to the swift accumulation of eroded materials from the upstream area. The major irrigation projects of Purulia constructed by the State government are Murguma dam, Fuitary dam, Totko Irrigation dam, Kayrabera dam, and Kansabati reservoir, besides a number of check dams, viz., Baghbinda check dam, Kuki check dam, Narahara check dam, Dimu Dam, Murguma dam, Pardih check dam, Turga check dam, Ghatbera check dam, Bara Urma check dam, Hanuman check dam, Berada check dam, Bhalo dam, Rajnowagar check dam, Dhobani check dam, Kadam Jora check dam, Patloi check dam, Bhalukga Jora check dam, Patloi check dam, and Gosaindanga check dam, etc. All the check dams irrigate rabi crops in small pockets of land during the winter months***Ghatbera Check-dam*** *in Balarampur C.D. Block provides water for Rabi crops of small area during winter season.*

Photo Courtesy: *Author, March, 2023*

2.4.3 Role of Forest Department: Historically, the study area was once densely forested with Palash, Mahua, Arjun, and Sal trees (O'Malley, 1996). However, rapid deforestation has resulted in widespread vegetation loss. To address this, the Forest Department has undertaken initiatives to develop forestry in degraded lands, aiming to reduce wasteland and promote sustainable land use.

Annual plantation programs have been implemented, featuring species such as Eucalyptus, Sonajhuri, Akashmoni, Arjun, and Sesum. While these efforts aim to reduce wasteland and enhance soil health, the planting of Sonajhuri and Akashmoni has been found to have adverse effects on soil quality, leading to decreased fertility, moisture, and undergrowth (Mahato, M.K. & Jana, N.C. 2021).

Despite these efforts, the Forest Department's initiatives have failed to yield significant results in restoring the degraded lands in the study area. The State Forest Department has initiated efforts to promote eco-friendly and sustainable soil health management practices in selected areas (Katsir. et al., 2024). Some notable examples include: Notable examples of sustainable forestry initiatives in the district include teak trees in Ankro Mauza (Bandwan C.D. Block), sal forests in Turang Mauza (Manbazar-1 C.D. Block), mixed forests of Karamcha, neem, and palash in Raghunathpur Mauza (Barbazar C.D. Block), jatropha in Kulabahal Mauza (Hura C.D. Block), and Arjun in Arjunjora (Hura C.D. Block) and Bamnidi Mauza (Barbazar C.D. Block), among others. These are just a few examples of the district's many sustainable forestry initiatives.

2.4.4 Role of NGOs: Gramin Vikash Trust (GVT) is a nationally recognized organization affiliated with Krishak Bharti Cooperative Limited (KRIBHCO) and funded by the Government of India. GVT's primary objectives include Natural Resource Management, Soil and Water Conservation, Animal Husbandry, Agricultural Research and Extension, Sustainable and diversified agriculture, and Capacity Building (NMSA, 2014).

Gramin Vikas Trust (GVT) has been actively involved in Purulia district from 1995 to 2019, implementing various local-level tree plantation programs sponsored by the National Bank for Agriculture and Rural Development (NABARD). These programs introduced important plant species like Akashmani, Sonajhuri, Sesame, and Mango, promoting sustainable development and environmental conservation in the region. GVT's initiatives in Purulia district are part of its broader objectives, which include natural resource management, soil and water conservation, animal husbandry, agricultural research, and capacity building (Bhattacharya.et al., 1985 & 2001).

2.4.5 Role of World Bank: The World Bank has made notable contributions to agricultural development in Purulia, West Bengal, through initiatives like the West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP). This project focuses on enhancing irrigation systems, fostering community-based institutions, and providing agricultural support services. Its primary objective is to improve agricultural productivity and livelihoods, ultimately benefiting local farming communities (Report; the World Bank, Sept 2020).

The World Bank has indeed made significant contributions to agricultural development in Purulia, West Bengal, India. Although Purulia is not a direct beneficiary of specific World Bank projects, the organization's broader initiatives in India promoting agricultural development, sustainable livelihoods, and rural growth have indirect benefits that positively affect the Purulia region (Report; the World Bank, Sept 2020).

The initiative has led to the establishment of large water bodies throughout the district, bolstering agricultural development, irrigation, rural livelihoods, soil conservation, and capacity building, ultimately benefiting smallholder farmers. These water bodies have played a crucial role in transforming the district's agricultural landscape, driving growth, and improving the livelihoods of local communities.

2.5 Proposed Management Measures for the Development of Wastelands in the Study Area

Efforts to develop infrastructure and support from agencies in Purulia district have fallen short, leaving concerns and uncertainties that call for innovative and effective solutions. Based on the previous discussion, the focus should now shift from ineffective strategies to practical, actionable suggestions that can drive effective wasteland development.

Therefore, the following proposed measures will be crucial in restoring fallow land and transforming it into productive land.

2.5.1 Preventing Soil Erosion: Most of the erosion-prone parts of the district, generally the gullies and troughs, steep slopes of uplands (*Tanr*), and boundaries of agricultural fields *(Aayir*), can be prevented through soil conservation methods. Gully plugging and constructing concrete (*Pucca*) and earthen (*Kutcha*) bunds are indeed effective measures to control soil erosion and promote soil conservation.

The western part of Purulia is more prone to gully erosion, necessitating the immediate construction of bundhs and the planting of appropriate vegetation and grasses adjacent to the gullies.

In ***Mahakudar Mouza, Jhalda-1 C.D. Block,*** sal saplings have been planted on Narahara hill's slopes. Due to the lack of groundwater, the forest department has arranged for clay pots to water the saplings, ensuring their survival.

2.5.2 ***Rain Water Harvesting:*** Although Purulia district gets enough rainfall during monsoons, the main challenge in wasteland management is ensuring water supply for irrigation, particularly during pre-monsoon and post-monsoon periods (Central Ground Water Board, 2022). To address this challenge, implementing effective water conservation techniques, such as rainwater harvesting and the construction of check dams, can play a crucial role. Additionally, promoting sustainable agricultural practices will help optimize water usage and improve crop yields throughout the year. This approach can create a positive feedback loop, where sustainable agriculture and ecosystem conservation reinforce each other, leading to long-term benefits for both the environment and human well-being.

Limited examples of rainwater harvesting have been added to the construction of ponds and check dams across the district since 1995, but the "***Jal Dharo-Jal Bharo***" project launched in 2011-12 to convert fallow land into agricultural land has changed the agricultural landscape of the district considerably in 2024. The project has not only increased the availability of water for irrigation but also enhanced the soil quality, leading to improved crop yields and greater farmer income. But it is also necessary to pay attention to increasing the water-holding capacity of the reservoirs in the erosion-prone district of Purulia. This can be achieved through the implementation of effective soil conservation practices and the restoration of natural vegetation. By enhancing the water retention capabilities, we can not only mitigate erosion but also support local agriculture and improve the overall ecosystem health.

Excavation of water body under MGNREGS in Mathari-Khamar GP of Jhalda-I C.D. Block

2.5.3 Recharge through abandoned dug-wells, bore-wells or tube-wells: Another proper method that can be used for developed water levels in this area is recharge through the construction of dug wells and the storage of surface water (Muthuminal R. and Mohana Priya R., 2022). The rainwater of the reservoir, tank water, or canal water, etc., can be displaced directly into recharging the groundwater. Putting on such a model for harvesting rainwater and recharging it into dry structures may increase the water table and assist the agricultural activities throughout the year. This approach not only enhances the availability of water but also promotes sustainable agricultural practices by ensuring that crops receive adequate moisture during dry spells. Furthermore, it can contribute to

improving the overall ecosystem health, as the replenished groundwater can support local flora and fauna.

2.5.4 Selection of Crops and Crop Suitability: The cultivable wastelands and fallow land in the study area are suitable for kharif production, selecting mainly the 'short duration paddy,' while in other seasons potato, mustard, sunflower, til, groundnut, and maskalai can be produced with the help of irrigation facilities. Persevering predominantly with the 'short duration paddy' for a few successive years may provide a large amount of yield in surplus, retaining the productivity of the land (NBSS&LUP, 2007). The land of Purulia district has been classified into five categories, such as Tikor, Tanr/Barhi, Baid, Kanali, and Bahal. The regional soil texture, soil fertility, water-holding capacity, surface and groundwater potentiality, irrigation facilities, etc., depend on those land categories. So, agricultural systems and cropping patterns are fully influenced by the characteristics of land categories (Mahato and Jana, 2019).

2.5.5 Continuous Cropping*:* Continuous cropping does not mean cultivation throughout the year, rather than not leaving the land as fallow for a long time, which may convert it to a degraded land. Commonly, the big farmers leave their marginal land uncultivated for a long time (Khan, 1990). These lands, which have been left as fallow land for more than five years, should be converted into degraded land. So, there will be a need for a yearly cropping system based on suitable crop selection.

2.5.6 Agro-Forestry and Social Forestry*:* Agro-forestry plays a crucial role in preventing soil erosion by utilizing live hedges as trench barriers, which help to stabilize the soil and prevent topsoil loss due to water or wind erosion (Kumawat, et al., 2020). This approach not only conserves soil but also promotes sustainable agriculture and ecosystem health. This approach to land management can help restore degraded lands by promoting soil health and fertility. By choosing the right tree species for mixed plantations, considering factors like maturity duration, productivity, and nutrient-water relationships, landowners can create more sustainable and resilient ecosystems.

The social forestry development program has multiple objectives, including meeting the demand for fuel, fodder, and timber, while also enhancing land capability and soil longevity. By promoting tree growth on uncultivated lands, this initiative can contribute to sustainable land management, environmental conservation, and improved livelihoods for local communities.

The social forestry development program has several goals, including meeting the demand for fuel, fodder, and timber while also improving land capability and soil sustainability. This initiative can help to promote tree growth on uncultivated lands, resulting in sustainable land management, environmental conservation, and improved livelihoods for local communities. It also encourages community engagement and participation, allowing residents to play an active role in the stewardship of their natural resources. This comprehensive approach not only benefits the environment, but it also improves social ties and economic resilience within the community.

In the **Barabazar C.D. Block's *Lagudih Mouza*,** the land on the left is used for agroforestry, while the area on the right is used for potato cultivation. By adopting agroforestry practices, farmers can generate income from forest products while also growing potatoes for food, promoting sustainable livelihoods and land use. This approach can enhance rural development and improve food security.

Findings and Conclusion:

Wasteland of Purulia comprises seven distinct types, each with unique reuse possibilities determined by their specific characteristics and level of degradation. Of the seven-wasteland types in Purulia, industrial wasteland has the most catastrophic impact, leaving land irreparably degraded and useless. The area seems likely to remain barren and unusable forever into the future. The Barbazar block's basalt mine wasteland has a dual impact: detrimental to biodiversity yet beneficial to locals who utilize the rock pits as water reservoirs.

The soil in Gullied / Ravenous lands is drained with rainwater, so these areas should be planted with suitable soil-retaining trees. Rocky wastelands possess significant economic value, as their diverse stone resources (granite, basalt, limestone, mica, dolomite, etc.) are in high demand for various modern applications. Optimal utilization of degraded pastures can ensure the district's food and nutritional security.

The introduction of Sonajhuri plantations in place of native species like Sal, Palash, Sesum, and Mahua in Purulia is a concerning trend. This shift not only threatens the biodiversity of the region but also disrupts the local ecosystems that have thrived for generations. Conservation efforts must be prioritized to protect these native species and maintain the ecological balance. A more effective approach might involve prioritizing the conservation and restoration of native flora, promoting sustainable land use practices, and supporting biodiversity in the region. This holistic strategy could lead to healthier ecosystems, which in turn would provide essential services such as clean air and water. By fostering a deeper connection between communities and their natural surroundings, we can ensure long-term environmental resilience and sustainability.

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